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MAIN ARTICLE

Outcome of malleo-stapedotomy using the malleus relocation technique during revision stapes surgery

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Abstract

Objective: This study aimed to use a new otological technique, malleus relocation, to solve the problems of ossicular reconstruction undertaken during revision stapes surgery for incus necrosis.

Study design: Prospective study of 12 patients undergoing revision stapedectomy for incus necrosis, in the otolaryngology department of Mansoura University, Egypt.

Patients and methods: Twelve patients underwent ossiculoplasty between June 2004 and June 2007, as part of revision surgery for otosclerosis with incus necrosis. All patients underwent ossiculoplasty using the malleus relocation technique. Ossiculoplasty used the patient's own, necrosed incus between the relocated malleus and the footplate.

Results: Post-operative air–bone gap closure to within 10 dB was achieved in seven patients (58.3 per cent). An air–bone gap of less than 20 dB was obtained in 10 patients (83.3 per cent). Deterioration of bone conduction by 10 dB occurred in one case. No patients were left with a 'dead ear'. Patients' hearing was stable throughout the follow-up period (range six to 40 months; mean ± standard deviation 23.5 ± 12.8 months).

Conclusion: These findings indicate that malleus relocation, performed during revision stapes surgery, is a safe and efficient technique for the treatment of incus necrosis.

Key words: Otosclerosis; Stapes; Malleus; Stapedotomy; Otologic Surgical Techniques

Introduction

The most common manifestation of stapedectomy failure is the reappearance of conductive hearing loss. There are several causes for this, including prosthesis migration at the oval window, prosthesis displacement at the incus, oval window bony closure, oval window fibrous closure, incus necrosis, incus or malleus fixation, and a short prosthesis. These different causes can be identified only at the time of surgery.[1]

Erosion of the long process of the incus is frequently encountered during revision of stapes surgery. This problem is managed by repositioning the prosthesis higher on the incus. This is often difficult because of the tapered end of the long process of the incus. However, if the remnant of the long process extends over the oval window, this may be the preferred means of reconstruction.

In most cases, the long process of the incus is no longer useful. The prosthesis must be attached to the malleus, or the incus removed and replaced with a columella strut from the oval window to the malleus.[2]

Traditional methods for repair of incus erosion include placing an ossicular replacement prosthesis (in order to bypass the ossicular chain), interposing a sculpted ossicle or prosthesis, and using prosthetics designed to augment the eroded incus long process.[3]

This study aimed to evaluate the results of the malleus relocation technique, used during revision stapes surgery for incus necrosis.

Patients and methods

The study was approved by the ethical committee of Mansoura University Hospital.

This prospective study was conducted in the otorhinolaryngology department of Mansoura University between June 2004 and June 2007. The study included 12 patients in whom incus necrosis was detected during revision stapes surgery.

Patients were followed up post-operatively at one, three, six and 12 months; data from the last available follow-up appointment were also recorded.

Audiological evaluation was conducted using a clinical audiometer (Model OB 822, Madsen, Odense, Denmark). Pure tone audiometry (i.e. air conduction (AC) and bone conduction (BC) thresholds at

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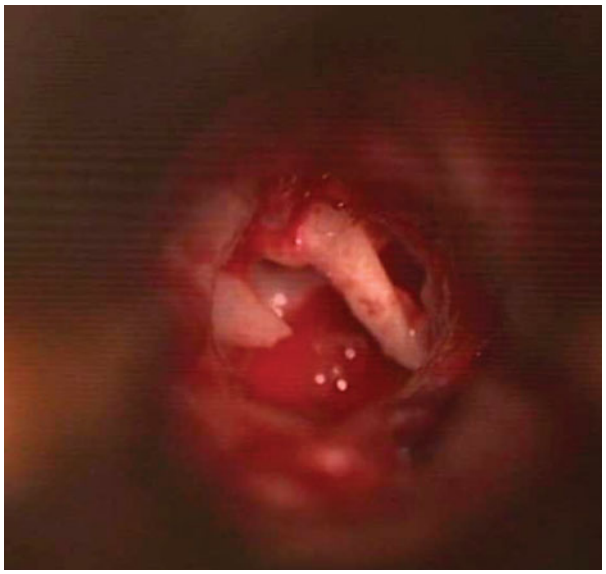

FIG. 1
Incus necrosis.

FIG. 2
Position of the malleus after relocation.

frequencies of 500 to 4000 Hz) was reviewed pre- and post-operatively during follow-up appointments. Results are reported in compliance with the American Academy of Otolaryngology–Head and Neck Surgery Committee on Hearing and Equilibrium guidelines for evaluation of the results of conductive hearing loss treatment.[4]

Statistical analysis was carried out using the Statistical Package for the Social Sciences version 10 software. Results were considered significant at $p < 0.05$.

Surgical technique

All operations were performed under local anaesthesia.

The middle ear was explored via a transcanal approach and the prosthesis removed. The malleus was dissected completely from the tympanic membrane and the incus removed (Figure 1). The tensor tympani was then sectioned, using a sickle knife, anterior to the neck of the malleus. The malleus was retracted posteriorly until it lay above the footplate (Figure 2). The distance from the footplate to the relocated malleus was determined using a measuring rod. The necrosed incus was reshaped so as to have one tapered end (fitting into a hole on the footplate) and one grooved end (accommodating the handle of the malleus). A temporalis fascia graft was used to seal the oval window. The tympanic membrane was returned to its original position, and the external canal was packed with Gelfoam® soaked with antibiotic ointment.

Results

Patients comprised eight men and four women. Their average age was 38 years (range 21–55; standard deviation (SD) ±10). The follow-up period ranged from six to 40 months, with a mean of 23.5 months (SD ±12.8). The right side was involved in five patients (41.5 per cent) and the left side in seven (58.5 per cent). The mean interval between the primary stapedectomy and the revision surgery was 4.9 years (range 1–12; SD ±3.4). Hearing results are shown in Tables I and II.

Patients' mean pre-operative AC was 50.7 dB (range 38.7– 65; SD ±8.6); their mean post-operative AC was 32.7 dB (range 16.25–56.25; SD ±11.05) (Figure 3). This AC improvement was statistically significant ($p < 0.05$).

Patients' mean pre-operative BC was 19.2 dB (range 12.5–30; SD ± 5.04); their mean post-operative BC was 21.1 dB (range 12.5–31.25; SD ± 5.01) (Figure 4). This difference was statistically insignificant.

TABLE I
PRE- AND POST-OPERATIVE AIR–BONE GAP

Time point	ABG (dB)		Patients in ABG categories (%)						
	Mean	SD	≤0 dB	1–10 dB	11–20 dB	21–30 dB	31–40 dB	41–50 dB	>50 dB
Pre-op	31	6.5	0	0	0	33	67	0	0
Post-op*	12	8.6	0	58	25	17	0	0	0
Post-op†	13	8.5	0	34	50	8	8	0	0

Air–bone gap (ABG) was measured at 0.5, 1, 2 and 4 kHz. *Air conduction versus post-operative (post-op) bone conduction; †air conduction versus pre-operative (pre-op) bone conduction. SD = standard deviation

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TABLE II
POST-OPERATIVE AIR AND BONE CONDUCTION CHANGES

Parameter	Mean	SD	Patients in threshold change categories (%)						
			< − 20 dB	−19 to −10 dB	−9 to 0 dB	1–10 dB	11–20 dB	21–30 dB	>30 dB
BC*	1.8	5.3	0	0	42	58	0	0	0
AC†	−19.5	11.7	42	25	17	0	0	0	0

*At 0.5, 1 and 2 kHz; †at 4 kHz. SD = standard deviation; BC = bone conduction; AC = air conduction

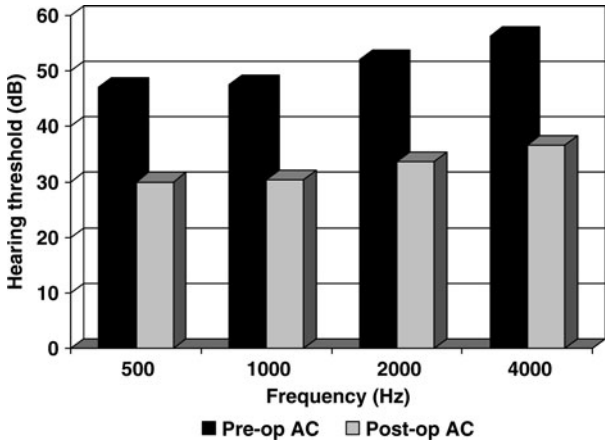

FIG. 3
Patients' mean pre-operative (pre-op) and post-operative (post-op) air conduction (AC) thresholds.

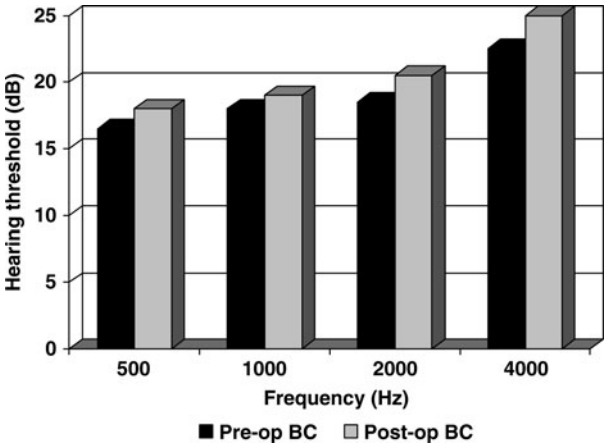

FIG. 4
Patients' mean pre-operative (pre-op) and post-operative (post-op) bone conduction (BC) thresholds.

The patients' mean air–bone gap (ABG) improved from 31.4 dB pre-operatively (range 21.25–38.75; SD ±5.6) to 11.5 dB post-operatively (range 3.75–30; SD ± 8.6). This improvement was statistically significant ($p < 0.05$).

Closure of the ABG to within 10 dB was achieved in seven patients (58.3 per cent), while ABG closure to within 20 dB was achieved in 10 patients (83.3 per cent).

A 10 dB deterioration in BC occurred in one patient. No patients were left with a 'dead ear'.

Patients' hearing was stable throughout the follow-up period.

Discussion

Although primary stapedectomy is one of the most successful otological procedures, the results of revision stapes surgery have been disappointing. A surgeon performing revision stapedectomy should be prepared to encounter and correct a wide range of surgical findings.[5] Revision stapes surgery is one of the most demanding otological procedures, in terms of the wide variety of pathological findings which can be encountered, and the numerous techniques potentially required to correct the cause of failure.[6]

Occasionally, otological surgeons will encounter incus necrosis during revision stapes surgery, and will need to decide which technique is suitable in each case.

Many techniques have been previously described for the management of incus necrosis.[2,3]

When considering ossicular reconstruction, the presence of an anteriorly positioned malleus presents the otological surgeon with a difficult problem: the axis of the malleus is not above the oval window, thus making reconstruction potentially difficult and unstable. In the present study, we use the malleus relocation technique, which brings the malleus above the axis of the oval window and reduces to zero the angle between the malleus and the footplate, allowing better placement of the reshaped incus between the footplate and the handle of the malleus.

- **This study evaluated the use of malleus relocation to achieve ossicular reconstruction, following the discovery of incus necrosis at revision stapes surgery**
- **The study assessed 12 patients undergoing ossiculoplasty during otosclerosis revision surgery involving incus necrosis, from June 2004 to June 2007**
- **Malleus relocation is a safe and efficient technique with which to manage incus necrosis discovered at revision stapes surgery**

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TABLE III
PATIENTS' HEARING RESULTS AFTER MALLEO-VESTIBULOPEXY: PUBLISHED DATA

Study	ABG <10 dB (%)	ABG <20 dB (%)
Feldman & Schuknecht[9]	37	63
Lippy & Schuring[10]	70	–
Pearman & Dawes[11]	58	75
Lippy & Schuring[12]	45	90
Lippy & Schuring[13]	79	–
Farrior & Sutherland[14]	37	78
Kisilevsky *et al.*[15]	60	–
Current	58	83

ABG = air–bone gap

Previous authors have reported variable hearing results following malleo-vestibulopexy for revision stapes surgery (Table III).[9–15]

The results of our study were comparable with most previously published findings. In addition, aligning the long axis of the malleus with the long axis of the oval window rendered the reconstruction simple and stable.

Conclusion

When faced with incus necrosis during revision stapes surgery, the technique of malleus relocation renders the reconstruction easy and stable, with results comparable to those of previous publications.

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